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A New Bog-lemming (*Synaptomys*) from Meade County, Kansas

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ABSTRACT: A new bog-lemming, *Synaptomys cooperi paludis* nov. subsp. is described from Meade county, Kansas. The type and eighteen paratypes were collected from a bog area in association with *Sigmodon hispidus*, *Peromyscus maniculatus*, *Reithrodontomys megalotis* and *Cryptotis parva*.

THE Kansas University Museum of Vertebrate Paleontology has been collecting vertebrate fossils in Meade county, Kansas, during the past six summers. Since the vertebrates obtained have been chiefly Upper Pliocene and Pleistocene mammals, we have endeavored to make a thorough study of the recent mammalian fauna for comparison with the Pleistocene faunas of that region.

Feces of *Synaptomys* were observed during the summers of '37, '38, and '39 in the bog areas situated in the Meade County State Park. During these summers attempts to collect the lemming ended in failure, since the traps were sprung by cotton rats. Cotton rats are abundant in the area throughout the meadows, weed patches along the streams, and in the bogs. The only trap used was the "Museum Special" snaptrap which was not large enough to hold the cotton rats. When entering the area the summer of '41, a new effort was made to collect the lemming. A large series of snap rat traps was obtained to catch out the cotton rats from the bog area. Examination on the seventh of July of the bog area showed abundance of cuttings and feces left by the lemmings. A trap line of 400 traps was put out around the edge of the bog, nearly every other trap being a rat trap. The first evening the traps were set, a number of *Sigmodon hispidus* were caught before the trap line was completed. The traps were run and baited three times each day during the first five

days. In the first twenty-four hours beginning July 7, seventy-six *Sigmodon* were taken. In two weeks more than 200 *Sigmodon* had been removed from the area. After the first five days the "Museum Special" snaptrap was moved into the best areas of the bog for trapping of the lemming. Over a period of nineteen days beginning July 8, twenty-one specimens of *Synaptomys* were taken, of which two were females. These have been compared with the other races known in North America and have been found to differ appreciably from the other forms.

We are greatly indebted to the following persons: Messrs. Ralph Taylor, Henry Setzer, Jack Twente and Henry Hildebrand, members of the field party, who helped to trap the above series of specimens; to Mr. Lee Larrabee, chairman of the Kansas State Fish and Game Commission, Mr. John Carlton and Mr. Leonard Sutherland of Meade County State Park for permission to study in the area and for courtesies shown our party; also to the following persons for the loan of specimens used in the study: Mr. C. D. Bunker, curator, University of Kansas Museum of Birds and Mammals, Lawrence, Kan.; Dr. W. H. Burt, curator of mammals, Museum of Zoölogy, University of Michigan, Ann Arbor, Mich.; Mr. E. A. Goldman, of Biological Survey, Division of Wildlife Research, Washington, D. C.; Mr. J. LeRoy Kay, curator vertebrate paleontology, Carnegie Museum, Pittsburgh, Pa.; Mr. Woodrow Goodpaster, Cincinnati Society of Natural History, Cincinnati, Ohio; and Dr. G. C. Rinker of Hamilton, Kan.

The new bog-lemming may be designated as *Synaptomys cooperi paludis* subsp. nov.

Holotype.—Male adult, skull and skin, No. 13713, collection of Kansas University Museum of Mammals: collected by Claude W. Hibbard, July 12, 1941, from the bog area surrounding brooder pond No. 1, Meade County State Park, fourteen miles southwest of Meade, Meade county, Kansas.

Paratypes.—Nos. 13708, adult male; 13709, immature male; 13710, adult male; 13711, adult male; 13712, immature male; 13714, immature male; 13715, immature male; 13716, adult male; 13717, immature male; 13718, subadult male; 13719, adult male; 13720, adult female; 13721, immature male; 13722, immature male; 13723, adult female; 13724, adult male; 13725, immature male; 13726, immature male.

Distribution.—Known only from bog areas found in Meade County State Park (see discussion).

Diagnosis.—Larger than *Synaptomys cooperi gossii* (Coues) Measurements in millimeters of type: total length, 146; tail, 23; hindfoot, 22; ear, 13. Skull heavier, larger and broader; color, bright cinnamon (neutralized sandy orange). Guard hairs thicker and more bristlelike, giving a darker appearance to the individual than in specimens of *S. cooperi gossii*.

Color.—Type, upper part of body a bright cinnamon (Ridgway, 1886), base of hairs plumbeous. Guard hairs black, bristlelike. Flanks grade into color of underparts, the hairs of which have a plumbeous base, tips silver, with light wash of cinnamon in middle region of belly. Under fur on hip glands slightly lighter than surrounding under fur. "Mustache" prominent with numerous black bristles much shorter and heavier than the vibrissae.

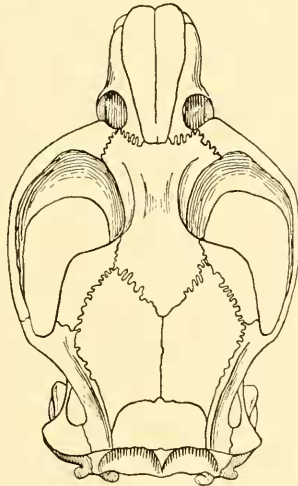


FIG. 1. *Synaptomys cooperi paludis* subsp. nov. holotype, No. 13713. Kansas University Museum of Mammals. Dorsal view of skull. $\times 2$.

Skull and dentition of type.—Skull similar to *S. c. gossii* but larger, the greater length of the skull being the region posterior to M^3 . The bullae are larger. Interorbital ridges heavier, more pronounced but separated by a wider groove in the interorbital region. Temporal ridges are continuous with the interorbital ridges, being better developed along the parietal and squamosal boundary. Measurements in millimeters; condylobasal length, 28; zygomatic breadth, 18.6; incisive foramen, 5; maxillary tooth row, 7.3; width of upper incisors (normal, one groove each), 4.1; mandibular tooth row, 7; greatest width of lower jaws measured across tips of angles, estimated, 17.9 (lower jaws separated in type).

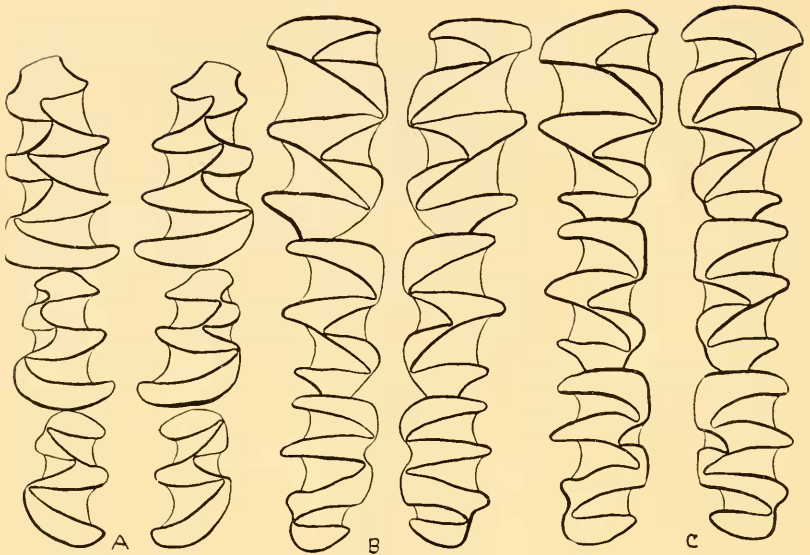


FIG. II. Teeth of *Synaptomys cooperi*. A. *Synaptomys c. paludis* subsp. nov., holotype. Oclusal view LM₁-M₃ and RM₁-M₃. $\times 10$. B. *Synaptomys c. paludis* subsp. nov., holotype. Oclusal view RM¹-M³ and LM¹-M³. $\times 10$. C. *Synaptomys c. gossii* (Coues), topotype, No. 5016, Kansas University Museum of Mammals. Oclusal view RM¹-M³ and LM¹-M³; note abnormal pattern of M³. $\times 10$.

Variation.—The immature specimens are plumbeous. The smallest specimen taken is a male 97 mm. in length. The adult color is beginning to appear on the muzzle and just anterior to the ear region. A male 116 mm. total length has an increase of adult coloration in the head region and the appearance of adult coloration as a small patch in the hip region. Another male 120 mm. in length has the adult coloration covering the head region, forelimbs and shoulders, hips and in the flank regions. A female 115 mm. in length possesses a greater amount of adult coloration and looks much like an old worn pelage possessing a series of shed lines. The adult pelage covers the head except between the ears where there is a patch of immature pelage, forelimb, shoulders, hind limbs, hips, flank regions, also a small patch between shoulders and across top of the hip region. Between the ears, in the middle of the back and on the rump, adult pelage shows through the immature pelage.

Of the nineteen skulls of *S. c. paludis* available for study, ten possess upper incisors with two grooves each. The added groove in most specimens is as wide and deep as the outer or normal groove. The added groove appears in both young and adult specimens and does

not seem to be an age character. In one specimen, No. 13709, an immature male, the two grooves converge on the upper incisor, meeting at the alveolus. The appearance of this character is probably due to a large amount of inbreeding that must take place in a stock living in such a small area. The individuals surely do not travel much from one area to another area, since no skull or lower jaw has been recovered from owl pellets in Meade county. Owl pellets have been collected in the area for the past six summers, and from them have been recovered remains of all of the other small mammals found in the area.

Average and extreme measurements in millimeters of the type and seven paratypes, consisting of seven adult males and one adult female; skull, condylobasal length, 28.2 (27.5-29); zygomatic breadth, 18.6 (17.9-19.7); incisive foramen, 5.17 (4.9-5.6); maxillary tooth row, 7.54 (7.3-8.0); width of upper incisors, 3.95 (3.7-4.2); mandibular tooth row, 7.15 (6.9-7.5); greatest width of lower jaws measured across tips of angles, 17.47 (16.6-18.4). Average and extremes of seven adult males and one adult female (type and seven paratypes); total length, 147.5 (142-154); tail, 21.87 (18-23); hindfoot, 21.87 (21-22); ear, 12.87 (12-14).

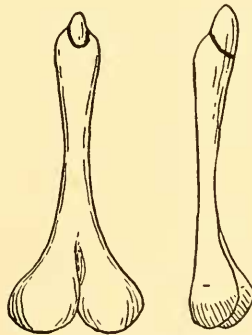


FIG. III. *Synaptomys c. paludis*. Baculum, dorsal or ventral view (probably dorsal) and lateral view. $\times 12$.

Only one baculum was recovered, and this was freed from the dried penis in the laboratory, so it is impossible to know which is the dorsal or ventral side. On the anterior end is a second center of ossification, producing a small bone separated from the main shaft by a thin layer of cartilage in the individual recovered.

The two females possessed mammae numbering $\frac{1}{1} \frac{2}{2}$.

Comparison of S. c. paludis with S. c. gossii (Coues).—The one topotype from Neosho Falls, Woodson county, an adult female in fall pelage, is a dull cinnamon (Ridgway, 1886). The other specimens from Anderson and Douglas counties were taken in fall, winter or spring. There is not a series of adults from any one season so as to be certain of the coloration of the pelage during a given period. Most of the specimens from Douglas county are isabella (Ridgway, 1886) in color. A few from Douglas county and those from Anderson county are intermediate in color between a dull cinnamon and an isabella. The Stafford county specimen, an adult female taken August 20, 1927, should correspond in color more nearly with that of the Meade county specimens, though it is distinct, being a fresh bistre (Ridgway, 1886), (deep sandy). We are indebted to Mr. Walter Yost for the analysis of the colors and for the comparison made with Ridgway's color chart.

In the Museum collection are 62 skins and skulls and 25 skeletons of *Synaptomys cooperi gossii* taken from the following counties in Kansas: Douglas, Anderson, Woodson and Stafford. These 87 specimens were collected during the following years: 1894, 1924, 1925, 1926, 1927, 1928, 1929, 1931 and 1937. Only one topotype exists in the collection, an adult female from Neosho Falls, Woodson county, No. 5016, length 135; tail, 23; hindfoot, 20; ear, 9. A single specimen, No. 5548, was taken from Little Salt Marsh, Stafford county, in 1927. The skull of this specimen has been lost. It is a female possessing adult coloration, length, 126; hindfoot, 20; tail, 15; ear, 11. From the series of 87 specimens of *S. cooperi gossii* from Kansas the eight largest specimens, 6 females and 2 males, have been selected for comparison with *S. cooperi paludis*. Their measurements are as follows: average and extremes, total length, 137.1 (134-148); tail, 19.75 (16-23); hindfoot, 20.5 (19-22); ear, 10.75 (8-14); condylobasal length, 26.7 (26.1-27.5); zygomatic breadth, 17.28 (16.6-17.9); incisive foramen, 4.97 (4.8-5.2); maxillary tooth row, 7.2 (6.8-7.4); width of upper incisors, 3.3 (3-3.5); mandibular tooth row, 6.75 (6.5-7.1); greatest posterior width of lower jaws measured across tips of angles, 15.2 (14.4-16.2).

The most conspicuous difference observed between *S. c. gossii* and *S. c. paludis* is the greater width across the angles of the lower jaws of the latter. The spread of the angle on each individual half of the lower jaw in adult specimens is twice as wide as the angle on adult specimens of the same sex of *S. c. gossii*.

Food and habits.—Only two plants were found to comprise the

food of the *Synaptomys*—these being *Equisetum* sp. and a large sedge. The *Equisetum* occurred in a rather large patch of perennial foxtail (*Setaria geniculata* (Lam.) Beauv.). The *Synaptomys* had no runways in this area either underground or above ground. Over eighty percent of the *Equisetum* stalks in this area were cut, the lemming eating a small portion, leaving the stalk cut into lengths from 1½ to 2 inches long. These small piles of cuttings were abundant, ranging from six inches to three feet apart in the area, depending upon the abundance of *Equisetum*. Under each pile of cuttings were abundant feces of the *Synaptomys*. The tall sedge was cut in the same manner; though the sedge was more abundant, it was not used for food as much as the *Equisetum*. Many sedges occurred in the bog, only one was observed to have been used for food; there were also grasses and some rushes, although the latter two were never found to be used for food. No individuals were observed feeding; however, in the evening when traps were being set just at sundown, the *Synaptomys* could be heard feeding and cutting the sedge. It was possible to approach within five to six feet of an individual, but the plant growth was so dense that one could not see through it. On parting the sedge, a fresh pile of cuttings would be found with fresh feces underneath.

A. Brazier Howell, (1927) p. 8, makes the following comment in regard to the molar teeth of *Synaptomys*. "The molars, although hypsodont, never project so far beyond the alveoli as do those of most other genera of microtines with hypsodont dentition, and hence there is less provision made for rapid wear. Therefore, the teeth must be unusually resistant, or else the food is less abrasive than is that of most voles. Of these two theoretical explanations, the former is considered unlikely. The facts as known seem to justify the conclusion that the molars grow at a less rapid rate than in most other genera of the subfamily, and hence are of a less pronounced order of hypsodontism." The type of plants which were observed to have been fed upon by the lemmings, such as, *Equisetum*, which contains large amounts of silica and the sedge, which also contains considerable silica, indicate that the molar teeth are very resistant to wear, and moreover that they are kept well worn by the type of vegetation eaten and may, in fact, grow far more rapidly than the molars of other forms feeding upon food with a smaller silicious content. Oatmeal, catmeal and raisins, and apple were used as bait in trapping; in no case were the *Synaptomys* known to have taken the bait. The traps were set in most cases where there were fresh cuttings and the

catch seems to have been accidental. The number of traps set in the areas used by the *Synaptomys* would allow for a number of chance catches without the taking of any bait.

The entire bog was combed for runways and nests. A few runways were found leading into nests of old grass, but owing to the abundance of rain they were water soaked, and it was impossible to tell whether they had been used by *Synaptomys*. During most of the period of trapping, water covered much of the bog from one-fourth to two inches in depth. The area was revisited the last of August and the signs of *Synaptomys* were as numerous as before any trapping was done in the area in July.

As stated above, over 200 *Sigmodon hispidus* were removed from the bog area and around its edges; few cotton rats were taken from the heavy sedge growth, but they overran the grass areas and especially the area where the perennial foxtail and *Equisetum* were found. Harvest mice, *Reithrodontomys megalotis* (34 specimens taken) and *Peromyscus maniculatus* were common throughout the area. *Peromyscus* was next in abundance to *Sigmodon*. Also, there were eight specimens of *Cryptotis parva* taken from the area.

Discussion.—Those not familiar with Meade county, and looking only on a map for reference would wonder greatly at the presence of *Synaptomys* in the so-called "Dust Bowl." Western Meade county lies in the High Plains section while the eastern part of the county is in the Plains Border section as defined by N. M. Fenneman (1930). Crooked creek is the major stream flowing through the greater portion of the county. Chiefly along the west side of Crooked creek and along the tributary streams leading into Crooked creek are numerous artesian springs. A few of these occur on the east side of Crooked creek. They extend from above Fowler, Kan., southward to Meade County State Park. The discharge from these springs is from a few gallons up to more than 800 gallons a minute. For further reference see Frye (1940). This flow is deep seated and usually produces a quicksand area at the place of discharge. Around the discharge areas, bogs have been developed that support many plants, especially, sedges, grasses, rushes, reeds, cattails, etc. The bog areas are favorable to *Synaptomys*. Many acres of meadow land occur along the flood plain of Crooked creek which have not been drained or heavily pastured, and should furnish a suitable habitat for *Synaptomys*.

At the present time *Synaptomys c. paludis* is known only from bog areas in the State Park, but should be found in the other iso-

lated bog areas which furnish suitable food and cover. The probable range should be along Crooked creek in Meade county, marshy areas along the Cimarron river in Seward and Meade counties, also in Beaver county, Oklahoma. They should be found along portions of the Beaver river in Beaver county, Oklahoma, where we have observed favorable habitats, though we have not had time to examine them. The range of *Synaptomys* in Meade, Seward and Beaver counties must have been widespread along the stream valleys when the country was first settled, for larger meadows existed along the flood plains of the Beaver and Cimarron rivers, and along Crooked creek. Many parts of the meadows were marshy and supported a large number of muskrats. The area between the true marsh and meadow would be the ideal area for *Synaptomys*. With the arrival of the "settlers" the meadows were cut for hay and burned in areas to furnish pasture. In many cases they were drained and plowed. Along the banks of the Cimarron river were large groves of native cottonwood as well as extensive meadows. The cottonwoods were cut, not only by the people along the river, but by those living on the plains. Following the settling of the country, large areas on the upland were plowed, heavy grazing was practiced and the beavers were exterminated.

Until 1914 the Cimarron river was narrow, with grassy banks and extensive meadows on the flood plain, a permanent stream of clear, flowing water with some deep pools and abundant fishes. Much hay was cut along the river, and only two short timbers thrown across the river were needed to transport the baler. On May 1, 1914, there occurred one of the greatest floods along the Cimarron watershed that has ever been known. Due to the cutting of the cottonwoods, the extinction of the beaver, extensive plowing in the upland, and heavy grazing, the fast runoff of the water scoured the Cimarron river bed in places to a depth of thirty-five feet. As the flood cut the channel deeper, it filled it with sand released by plowing and overgrazing. During the flood, the few trees which had not been cut were washed out and covered by sand. The river channel changed from that of a narrow stream with a few feet of clear water to a broad sand bed with many sand bars which allows the constant blow of sand along the channel carrying a shallow stream, whose water is silty most of the time. The down cutting of the river channel and filling with gravel and sand had the same effect as that of laying a large, deep-seated drainage tile through the area. The flood plain drained at once into the channel. Most of the river flow being under-

ground, the meadows dried out and the grasses died, being replaced by sagebrush, sand plums, buffalo gourds, and small sand dunes. Following along the banks of the Cimarron one may see exposed areas of dark soil full of plant remains marking the once common water table that supported the larger meadows and marshes. This change in the water table and flora along the Cimarron in recent times must have had a great effect upon the fauna. *Synaptomys*, which could once have been common along the valley, must now exist only in isolated areas. This same change has taken place along Crooked creek and the Beaver river, in part, but not as greatly as along the Cimarron.

Conditions seem to have been favorable for the occurrence of *Synaptomys* in Meade county and adjoining areas throughout the Pleistocene, both during certain phases of the glacial and interglacial stages and the Recent. Artesian springs which must have existed in the area since middle Pleistocene would help to maintain a natural habitat for this bog-lemming; also, the occurrence of sink holes has helped to provide isolated habitats. Sink holes began to appear in Meade and Beaver counties at the close of the Tertiary and have been present throughout the Pleistocene and into Recent times. These sink holes, when they have ceased to be active and have become plugged, form lakes in their basins around the border of which appear marshes and meadows. The life of these lakes is long and lasts either until the sink hole is filled, until they are dissected by head erosion of a stream or until the sink again breaks through and allows further drainage.

The oldest geological record of *Synaptomys* in Kansas is that of the subgenus *Mictomys*, specimens of which have been taken from the Pleistocene of Meade county below the horizon of the Borchers fauna. There is some evidence that these were associated with the boreal fauna that inhabited the area just prior to the Borchers fauna. *Synaptomys* (*Mictomys*) cf. *vetus* Wilson was reported by Hibbard (1941) from the Borchers fauna. This form was incorrectly referred by Hibbard to the subgenus *Mictomys*. It must be considered as belonging to the subgenus *Synaptomys*. Outer external triangles are not present or indicated in the M_1 and M_2 of the subgenus *Mictomys*, while the M_1 and M_2 of the *Synaptomys* from the Borchers fauna possess an open external triangle, a condition which can be observed to a lesser degree in some immature specimens of *S. cooperi*. *Synaptomys vetus* Wilson (1933) cannot be considered as intermediate between the two recent subgenera since it possesses the

open external triangles. *Synaptomys bunker* Hibbard (1940) is known from a later Pleistocene horizon than that from which the Borchers fauna was taken. It was taken from a dissected sink in Beaver county, Oklahoma, along the north side of the Cimarron river on the XI ranch. It is distinguished from *S. c. paludis* by its larger size, and the pattern of M_1 .

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